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Acanthocephala of the biocoenosis of Družno Lake
[Parasitofauna of the biocoenosis of Družno Lake — part VI]

Kolcogłowy biocenozy jeziora Družno
[Parazytfauna biocenozy jeziora Družno — część VI]

This work is only a fragment of the great problem concerning the circulation of parasites in the biocoenosis of Družno Lake and is based on the results of collective observations made on this lake during 1950, 1951 and 1953.

I was especially interested in ecological relations connected with the occurrence of *Acanthocephala* in the specific type of lake and the character of its biocoenosis.

Družno Lake is situated about 5 kilometres south-west of the city of Elbląg (in lat. 50°3' to 54°7' N and in long. 19°24' to 19°30' E). In its character it resembles a great shallow pond overgrown with plants. A channel joints the lake with the delta of the Vistula and, indirectly, with the Baltic Sea. The water surface of the lake amounts 1790 ha, the average depth 1.25 m, maximal depth 2.5 m and relative depth 0.0006 (Mikulski, 1955).

Materials and chronological data of research

The observations on the occurrence of *Acanthocephala* in birds and crustaceans were made by many participants of a great collective work. I have personally collected the material concerning birds in the year 1953. Thanks to the kindness of Dr J. Kozicka I obtained all the necessary data concerning fishes. Details concerning the invasion of frogs were given to me by Mrs W. Chodowska and Mr S. Kozłowski.

The research on parasitofauna of Družno Lake was made in spring, summer and autumn 1950—51 (April 16 — May 10, Jul. 5—Sept. 21, Nov. 5—20, 1950; May 7—12, Jul. 8 — Sept. 23, Nov. 16—24, 1951) and in summer 1953 (Jul. 9 — Sept. 16 — materials from birds only).

All the intestines of final hosts were examined. The larval parasites from isopods were examined with the help of a binocular magnifying glass, but our experience shows that in this case it is better to use a microscope, because it enables us to observe *Acanthocephala* in the earliest stages of their development, such as acanthor and acanthella. Worms were preserved and then their total preparations were made.

Acanthocephala in final host

In fishes

21 species of fishes living in Družno Lake were examined on the presence of *Acanthocephala* in their intestines. Six of them appeared to have these parasites.

Table I

No.	Host	Year	Number of examined fishes	Number of invaded fishes	Number of specimens of <i>A. lucii</i>	Percentage of invaded fishes	Average of invasion	Index of invasion*	Maximal number of parasites
1	<i>Perca fluviatilis</i> L.	1950	44	32	235	73	5.3	7.3	61
		1951	14	11	155	78	11.1	14.1	47
2	<i>Acerina cernua</i> L.	1950	21	12	37	57	1.8	3.0	15
		1951	2	0	0	×	×	×	×
3	<i>Esox lucius</i> L.	1950	29	5	24	17	0.9	4.8	8
		1951	34	7	28	20	0.8	4.0	12
4	<i>Anguilla anguilla</i> L.	1950	0	0	0	×	×	×	0
		1951	0	1	2	×	×	×	2
5	<i>Abramis brama</i> L.	1950	26	0	0	0	0	0	0
		1951	23	1	1	4	0.04	×	1
6	<i>Tinca tinca</i> L.	1950	16	0	0	0	0	0	0
		1951	12	1	1	×	×	×	1

× — means the number of data being too small to make computations.

* The index of invasion (Kozicka, 1951) is the quotient of a total number of parasites of one species found in examined hosts to the total number of invaded hosts.

The most common acanthocephalan parasite in Družno Lake appeared to be *Acanthocephalus lucii* Müll. This parasite was found in the intestines of the representatives of six species of fishes. Only one of them (*Anguilla anguilla* L.) is rather rare in this lake, the other five are the most common. The following table shows the number of examined fishes which appeared to be invaded with *A. lucii* during two years.

The classification of the species in the table is based on the position taken by the said species in the great quantity of the final hosts. The main host of *A. lucii* is a perch than a ruffe and a pike. If any other species was invaded with this parasite it happened only by accident. I could not define the position of the eel since only one specimen of this species was examined. The fact that *A. lucii* is more frequent in the intestines of *Perca fluviatilis* and *Acerina cernua* than in the intestines of *Esox lucius* does not mean that this parasite is more typical of them. Its occurrence is connected only with the difference in the food absorbed by these two species in relation to the third one; *Asellus aquaticus* (the intermediate host of *A. lucii*) appears more frequently in the food of a perch and ruffe than in that of a pike. When the food is changed, the number of parasites in the intestine changes simultaneously. I should like to quote here the observations made by K o z i c k a. In winter 1953 she found in the intestines of some pikes about 40 acanthocephalans while the stomachs of so heavily invaded fishes were filled with aquatic isopods. It proves that pikes in the ice-covered lake would pick smaller fauna from the bottom of the lake.

The exceptional presence of *A. lucii* in fishes belonging to *Ciprinidae* does not mean that they are their normal hosts, but the opposite stand of L ü h e (1911) concerning the possibility of invasion of *Ciprinidae* with *A. lucii* was not proved by the observations made at Družno Lake.

Besides this one specimen of *Acanthocephalus anguillae* Müll. was once found in the intestine of *Tinca tinca*, two singular specimens of *Neorhynchus rutili* Müll. were found in *Abramis brama* and in the one single case four specimens of *Corynosoma strumosum* Rud. occurred in the intestine of *Esox lucius*. This last case is an exceptional one because usually *C. strumosum* has as its final hosts either sea-mammals (*Phoca* sp.) or some birds from the genus *Phalacrocorax*; fishes are only the transport hosts of the parasites living in their body-cavity. It is possible that an invaded

pike came to Družno Lake from the delta of the Vistula through the channel, and the acanthocephalans did not enter the body cavity till the moment of its examination. In any case, this species is a foreign element in the biocoenosis of Družno Lake.

In frogs

Frogs of Družno Lake and its nearest environment examined in 1950—51 were represented by three main species: *Rana esculenta* L., *R. temporaria* L., and *R. terrestris* Andr. z. The only one acanthocephalan parasite found in them appeared to be *Acanthocephalus ranae* Schrank. The following table shows the number of frogs invaded with this parasite during three successive seasons.

Table II

No.	Host	Year season	Examined frogs		Invaded frogs		Percentage of invaded frogs	
			1950	1951	1950	1951	1950	1951
1	<i>Rana esculenta</i> L.	Spring	5	7	2	3		
		Summer	54	157	23	81		
		Autumn	0	7	0	2		
		Sa	59	171	25	86	44.0	50.0
2	<i>Rana temporaria</i> L.	Spring	4	13	0	2		
		Summer	15	16	8	3		
		Autumn	0	2	0	1		
		Sa	19	31	8	6	42.0	19.3
3	<i>Rana terrestris</i> Andr. z.	Spring	6	0	0	0		
		Summer	38	32	5	4		
		Autumn	0	21	0	1		
		Sa	44	53	5	5	11.3	9.6
Total			122	255	38	97		

As we can see, the most frequently invaded appears to be *Rana esculenta*, as a species more apt to live in water than any others.

The character of Družno Lake gives many possibilities for closing life cycle of *A. ranae* in the same habitat. It is caused especially by the fact that the frogs live in great quantities near

the banks of the lake while the intermediate host — *Asellus aquaticus* — is numerous there. The observations which I have made at Gołdapiwo Lake (Węgorzewo district) in 1954 proved that in different conditions of distribution of the hosts in the lake modified parasitological relations occur. *Asellus* in a shallow littoral zone of Gołdapiwo Lake appears only in some special places more eutrophic than the others. I stated that in these places where I found isopods there were no frogs — as a rule. Frogs would live in these parts of the littoral zone where there were no isopods. There is nothing peculiar that such ecological barrier as the lack of contacts between the hosts caused the decrease in the rate of invasion of the frogs of Gołdapiwo Lake.

Table III

No.	Host	Year season (1951)	Number of parasites found in examined frogs	Average of invasion	Index of invasion
1	<i>Rana esculenta</i> L.	Spring	7	1.0	2.3
		Summer	379	2.4	4.7
		Autumn	8	1.14	4.0
2	<i>Rana temporaria</i> L.	Spring	7	0.54	3.5
		Summer	4	0.25	1.3
		Autumn	2	×	×
3	<i>Rana terrestris</i> Andr z.	Spring	0	0.0	0.0
		Summer	5	0.15	1.3
		Autumn	1	0.05	×

Frogs living on the land are rarely invaded because they can get *Acanthocephala* only in spring during egg-laying, and later only if there are accidental contacts with the lake. But even these few cases of invasion are very important from the point of view of the existence and expansion of the species of parasite.

The role of several species of frogs in closing the life cycle of *A. ranae* is shown on the Table III.

R. esculenta consisting 66 % of the total number of examined frogs are most frequently invaded with acanthocephalans because in their intestines about 93 % of the total number of these parasites were found. The results of the observations made in summer 1951 prove that the total number of *Acanthocephala* found in a single specimen of *R. esculenta* varies from one to ten. A greater number

of worms is rather rare. Out of 80 invaded frogs only five (i. e., six per cent) appeared to have more than ten parasites. It is worth stressing that while in one frog there were 26 *Acanthocephalans* they were sexually immature. A certain limit of the maximal number of *Acanthocephala* in their final hosts is caused probably not only by the character of the lake. It seems to me that the frogs swallow more worms than we can state during dissection, but no parasites that enter the intestine of the final host surpassing

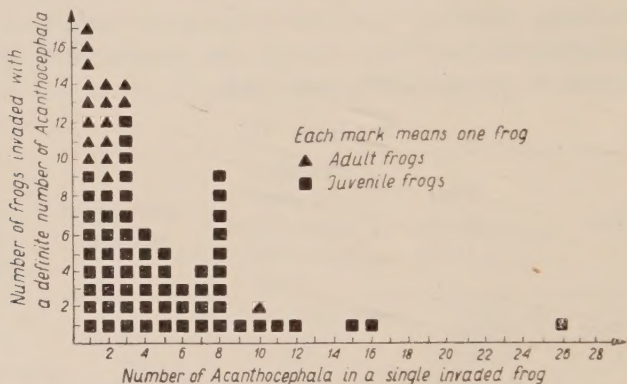


Diagram 1 illustrating the level of invasion with *Acanthocephala* of juvenile and adult *Rana esculenta* L. in summer 1951

a definite number can develop there. This suggestion is proved by the following fact: quite adult frogs examined in autumn (September 1951) had only mature specimens of *Acanthocephala* and the female parasites were full of embryos, while the juvenile frogs examined in the same time appeared to be invaded with juvenile *Acanthocephala*. It is possible that it is caused by the character of the habitat as well as by the dynamic character of host-parasite relation (Burlingame and Chandler, 1941; Michajłow, 1953; Pawłowskij and Gniezdilow, 1953; Wiśniewski, 1955).

The rate of invasion of the young frogs shows that they begin to eat aquatic isopods immediately after their transformation and that they are very soon invaded. Transformation of *R. esculenta* occur in August — the length of transformed juvenile specimens varies from 19 to 24 mm. I had divided the frogs examined in September into two groups according to their age: as younger I considered frogs which were 25 to 35 mm long, the older ones

were those transformed earlier — 35 to 45 mm long. Out of 38 young frogs examined from the first group, only eight appeared to be invaded with ten parasites. The index of invasion in this group was 1.2 and average of invasion 0.26. Out of the older group 16 frogs were examined. Nine of them were invaded with 19 acanthocephalans. The index of invasion appeared to be 2.0, and the average 1.18.

If we compare these data, we can see how quickly increases the number of parasites in young frogs. The rate of invasion is relatively higher in the older group, while the general rate for both groups is rather low (there I have omitted to mention one case which is not at all typical, i. e., that once I found up to ten acanthocephalans in a 30 mm long frog. Probably this frog lived in an environment of excessively invaded isopods).

In birds

In 1950—51 and 1953 there were examined about 188 birds belonging to the species more or less connected with water. The hosts of *Acanthocephala* appeared to be birds belonging to following species (Table IV):

Table IV

No.	Bird species	Examined specimens	Specimens invaded with <i>Acanthocephala</i>
1	<i>Anas platyrhynchos</i> L.	79	44
2	<i>Nyroca ferina</i> L.	8	1
3	<i>Nyroca fuligula</i> L.	1	1
4	<i>Nyroca nyroca</i> L.	40	9
5	<i>Querquedula querquedula</i> L.	12	3
6	<i>Fulica atra</i> L.	135	61
7	<i>Gallinula chloropus</i> L.	6	3
8	<i>Porzana parva</i> Scop.	3	2
9	<i>Philomachus pugnax</i> L.	7	3
10	<i>Tringa glareola</i> L.	9	2
	Total	300	129

These species from which at least seven representatives were examined without finding *acanthocephalans* in them were classified under the second group. They are not the hosts of *Acanthocephala* in the biocoenosis of Družno, and are presented as follows:

52 *Larus ridibundus* L., 33 *Podiceps cristatus* L., 21 *Chlidonias nigra* L., 18 *Sterna hirundo* L., 9 *Ardea cinerea* L., 7 *Anas strepera* L., 7 *Circus aeruginosus* L.

Nothing sure can be said about other species since the number of the specimens examined varies from one to five and there were no *acanthocephalans* in them. These species from which many specimens were examined are the most common at Družno Lake and form the dominant part of its avifauna. Therefore their parasitological relations with the lake are more important to the characteristic of the biocoenosis than parasitological relations of other species, more rarely found in this area.

In two birds from the second group, namely of *Larus ridibundus* and *Anas strepera*, there were once found single *acanthocephalan* specimens which pierced the wall of the intestine and became encysted on its external side, but they are dead and so much changed that it was impossible to define their species more precisely; possibly *L. ridibundus* and *A. strepera* were not their normal hosts.

Table V

No	Host	Number of examined specimens	Number of specimens invaded with <i>F. anatis</i>	Number of parasites found in examined birds	Percentage of invaded birds	Average of invasion	Index of invasion
1	<i>Anas platyrhynchos</i> L.	79	39	578	50.0	7.3	14.8
2	<i>Fulica atra</i> L.	135	60	252	44.0	1.9	4.2
3	<i>Nyroca nyroca</i> L.	40	9	41	22.5	1.0	4.5

I have marked only two species of *Acanthocephala* in birds at Družno Lake, namely *Filicollis anatis* Schrank and *Poly-morphus minutus* Goeze. *F. anatis* was found in all the represen-

tatives of the first group and *P. minutus* in *Anas platyrhynchos* (four times, the intensity of invasion appeared to be one to eighteen parasites), *Nyroca nyroca* (once one specimen) and *Nyroca fuligula* (once one specimen). Generally speaking *P. minutus* is rather rare. *F. anatis* is the most common species parasitizing in birds from *Anatidae* and *Rallidae* family. Its main host on Družno Lake is *Anas platyrhynchos*, then *Fulica atra* and in the third place *Nyroca nyroca*. Other hosts are of minor value, because they are less numerous at the lake and their influence on the circulation of *F. anatis* in the biocoenosis is relatively smaller. Table V shows data concerning the rate of invasion of dominant hosts during three years.

Similar invasion of two such different species as *Anas platyrhynchos* and *Fulica atra* is caused by the similarity of their food niche. *A. platyrhynchos* is most frequently invaded because it is more fed on animals than *Fulica* and *Nyroca* or simply it is more gluttonous. Such a classification of hosts is of course typical only of Družno Lake. In other biocoenoses considerable differences can be observed and different dominant hosts may occur.

Larvae of *Acanthocephala* in the intermediate host — *Asellus aquaticus* L.

The isopods examined were taken from seven stations into which the lake was divided. They were taken out of the lake with the help of a benthos drag then cleaned out from the mud and plants, and dissected under the binocular magnifying glass. 21 948 isopods were examined. During this examination there were found larvae of all *Acanthocephala* species common at Družno Lake, namely: *Acanthocephalus lucii* Müll., *A. ranae* Schrank, *Filicollis anatis* Schrank and *Polymorphus* sp. Lühe (a form probably belonging to the species *Filicollis anatis* — presence on the proboscis of the larva of 22 longitudinal rows of hooks instead of normal 18 was the only difference). The following table shows the number of examined isopods as well as the number of specimens from each species of *Acanthocephala* collected during three seasons of 1950 and 1951. Unidentified larvae belong probably to the species *Acanthocephalus lucii* but the retraction of the proboscis did not allow to define their species.

Table VI

Year season	Number of examined isopods	Number of invaded isopods	Percentage of invaded isopods	Index of invasion	Number of specimens					Total
					<i>A. lucii</i>	<i>A. ranae</i>	<i>F. anatis</i>	<i>Polymorphus</i> sp. Lüh e	Unidentified (<i>Acanthocephalus</i> sp.)	
Spring	1036	0	0	0	0	0	0	0	0	0
	12793	4	0.5	1.0	0	1	0	0	3	4
Summer	12869	178	1.4	1.1	118	2	5	0	83	208
	4104	44	1.1	1.0	28	0	1	1	15	45
Autumn	2755	19	0.7	1.0	7	1	3	0	8	19
	391	1	0.2	1.0	0	0	0	0	1	1
Total	21948	246	1.1	1.0	153	4	9	1	110	277

In the above table there is a striking disproportion between the frequency in the occurrence of *A. ranae* and *F. anatis* in their final hosts (see about the invasion of birds and frogs) and the number of larvae found in *Asellus*. *A. ranae* is the common parasite of frogs at Družno Lake, while in isopods the larvae were found only four times. This may be caused by the fact that the material for examination was not taken near the banks of the lake where the frogs live mainly. Similarly *F. anatis* is probably more frequent in the isopods from the places where there live a great number of birds that it seems from our analysis. Upon the two-years observations only nine juveniles of *F. anatis* were found. In spite of some possible errors in the collected material we may say that *A. lucii* is the dominant species of all *Acanthocephala* living at Družno Lake and developing in the body cavity of *Asellus aquaticus*; but the percentage of the intermediate hosts invaded with *A. lucii* is very low and index of invasion is never higher than 1.0, while in the intestines of final hosts we can find numerous acanthocephalans (compare data concerning fishes). These proportions are illustrated best by the occurrence of *A. lucii* in the intestine of *Perca fluviatilis* compared to the same occurrence in the body cavity of *Asellus*.

During two years in 54 examined specimens of *P. fluviatilis* there were found 390 specimens of *A. lucii* — the average of invasion for perch mounts to 7.2. In the same period in 21 948

examined isopods there were found 263 larvae of *A. lucii* (including the specimens which were not defined because of the retraction of proboscis) therefore the average of invasion for *Asellus* was 0.012. If we assume the average of *Perca* to be 100% the average of *Asellus* will be only 0.002% of this number.

Several species of *Acanthocephala* developing in isopods at Družno Lake mature in different final hosts. The high density of acanthocephalans in their final host proves that isopods consist a great part of the food of some birds, frogs and fishes. In the biocoenosis of Družno Lake may occur a certain limit in the population level of various acanthocephalan species developing in the same intermediate host by the non specific final hosts. Therefore fishes eating larvae of *F. anatis* and *A. ranae* cause the decrease of invasion of birds and frogs, on the other hand birds and frogs can eat isopods invaded with *A. lucii* and so on. It is worth stressing that isopods living in various parts of the lake can be invaded by various species of *Acanthocephala* according to different distribution of final hosts.

If the only final hosts are fishes or frogs the circulation of *Acanthocephala* in the biocoenosis can be limited and in fact is limited to one lake. In the case of migratory birds unexpected changes in the character of parasitofauna of the lake may occur. The fact that *Corynosoma strumosum* was found at Družno Lake can indicate some changes caused by the migrations of fishes, but we ought to consider this case as exceptional. *Polymorphus minutus* is a parasite strange to the Družno Lake. It was found sometimes in ducks. The invaded birds had possibly come from other lakes inhabited by *Gammaridae*, because at Družno Lake amphipods are very rare and appear only in one single part of the lake. *Neorhynchus rutili* comes probably from the same lake — because, while we have not found its larvae in Družno Lake, it is very possible that they occur in *Ostracoda* crustaceans. During my studies on acanthocephalans of Goldapiwo Lake I have met a single larva of *N. rutili* in the ostracode *Cyclocypris laevis*, which is very common in Družno.

Seasonal changes in the invasion of final hosts

The results of investigations carried during two years show that the rate of invasion of frogs increases in summer in comparison to the spring data. In spring 1950 as well as the next year

at the same time the invaded frogs consisted 25% out of the total number of examined specimens. In summer 1950 their percentage increased to 33 and in summer 1951 it amounted to 42. In autumn we ought to expect a decrease of this great number, but it was too difficult to examine an adequate number of frogs in November, therefore I was not able to assess conclusive data.

This regular increase of invasion is probably due to the length of the life cycle of *A. ranae* and indicates the annual cycle of parasite according to conclusions drawn by Komarowa (1950) for *A. lucii*. It seems that the span of life of *F. anatis* is also one year what can be proved by the following observations:

In spring (in the middle of May) we can find in birds only juvenile forms which had invaded their final hosts not very long ago. Later we can also find them but simultaneously with the older ones in various stages of development. The females of *Filicollis* are not mature till about August and in their body cavities we can find only egg-balls or immature embryos. Somewhat about the middle of August the embryos become mature and are able to invade isopods. The main part of production and embryos-laying starts — in the case of *F. anatis* — at the end of summer till the late autumn. After the expulsion of embryos the parasites possibly die, and in spring birds are invaded with the new generation of parasites, which in the meantime has developed in aquatic isopods. Van Cleave (1916) observed seasonal changes in the occurrence of two species of *Neorhynchus*. He says that the main causes of it are as follow: the length of life of the parasite in its final host, the length of the development in the intermediate host as well as seasonal changes in the food of final hosts. It seems to me that the above mentioned facts also depend mainly on these three factors.

The sexual structure of the populations of *Acanthocephala* at Družno Lake

The problem of sexual structure in the population is connected with the biological nature of species and is very important for the circulation of parasites in the biocoenosis. The analysis of sexual proportions of various species of *Acanthocephala* was settled on the basis of the following material:

1. 110 aquatic isopods examined in summer 1950;

2. 42 mature frogs examined in summer 1951;
3. 21 specimens of *Fulica atra* and *Anas platyrhynchos* examined in summer 1953.

My chief task was to give answer to the three main questions:

1. What is the sex-proportion between males and females?
2. Is there a great possibility for both sexes to meet in the same final host?
3. What are the sex-proportions in acanthocephalans belonging to the one species and occurring in a single host?

As to the first question the analysis shows that proportion between males and females varies in several species in favour of females as follow:

a. for *Acanthocephalus lucii* from *Asellus aquaticus* ca 1.5 : 1 (70 females and 41 males).

b. for *A. ranae* from *Rana esculenta* 1.5:1 (91 females and 49 males). Meyer (1933) mentioned it to be 2:1 in favour of males, but did not refer the origin of these data.

c. for *Filicollis anatis* from *Fulica atra* and *Anas platyrhynchos* 1.5:1 (99 females and 63 males).

It is possible that in some cases of the majority of females — males had leaved the intestine earlier, but the fact which I have stated concerning the majority of females is proved by the analysis of the larval material from isopods, where I found 70 females and only 48 males.

The answer to the second and third questions I have obtained by examining frogs. Acanthocephalans taken from a single frog I considered a single unit. To find the answer to the second question I examined 42 such units. 29 of them contained both sexes, six — only one sex (three males and three females) more-over there are five singular females and two males.

This proves that there is a great possibility for both sexes to meet in the same host, because the proportion of mixed units to unisexual is 4.8:1. It is quite obvious that the greater the average invasion of frogs, the greater this possibility. Moreover the units where the females appear to be in majority, are more numerous than the units with the majority of males and those with equal sex proportion (1:1). The relation of mixed units with the majority of females to those with the majority of males is 9:1. Other units were equal.

Generally speaking in the populations of acanthocephalans of Družno Lake there are more females than males. This fact is very favourable for the existence of the species of parasite, because the possibilities of fertilization are slightly diminished and the number of eggs produced by population increases.

Conclusions

1. Following final hosts of *Acanthocephala* were stated in the biocoenosis of Družno Lake:

Fishes: *Perca fluviatilis* L., *Acerina cernua* L., *Esox lucius* L., *Anguilla anguilla* L., *Abramis brama* L., *Tinca tinca* L.

Frogs: *Rana esculenta* L., *R. temporaria* L., *R. terrestris* Andr z.

Birds: *Anas platyrhynchos* L., *Nyroca ferina* L., *Nyroca fuligula* L., *N. nyroca* L., *Querquedula querquedula* L., *Fulica atra* L., *Gallinula chloropus* L., *Porzana parva* Scop., *Philomachus pugnax* L., *Tringa glareola* L.

2. The following *Acanthocephala* close their life cycles at Družno Lake and are common in its biocoenosis:

In fishes — *Acanthocephalus lucii* Müll. Dominant host — *Perca fluviatilis* (73 % of invasion).

In frogs — *Acanthocephalus ranae* Schrank. Dominant host — *Rana esculenta* (44 % of invasion).

In birds — *Filicollis anatis* Schrank. Dominant host — *Anas platyrhynchos* (50 % of invasion).

3. There are some parasites which may close their life cycle at Družno Lake, but are very rare, e. g., *Acanthocephalus anguillae* Müll. and *Neorhynchus rutili* Müll. occurring in fishes.

4. The following parasites are regarded as strange elements in the biocoenosis of Družno Lake: *Polymorphus minutus* Goeze — in birds, and *Corynosoma strumosum* Rud. — in fishes.

5. The only intermediate host of acanthocephalans common in the biocoenosis of Družno Lake is *Asellus aquaticus* L.

6. The rate of invasion of the first host is very low (generally about 1.1 % of invaded isopods). In the final hosts the rate and intensity of invasion increase very rapidly.

7. The intensity of invasion of final hosts depends on the percentage of isopods in the food as well as on some unknown factors connected with the host-parasite relationship.

8. It is supposed that the average length of life cycle of some acanthocephalans common in the analysed biocoenosis does not surpass one year, which is proved by seasonal changes of invasion.

9. In the populations of *A. lucii*, *A. ranae* and *F. anatis* there are more females than males — the sex-proportion appears to be 1.5 : 1 in favour of females.

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STRESZCZENIE

Autorka opracowała materiał zebrany przez kilka osób w czasie badań zespołowych nad krążeniem pasożytów w biocenozie jeziora Drużno. Na obecność *Acanthocephala* zbadano 21 gat. ryb poławianych w jeziorze, 3 gat. pospolitych płazów i 40 gat. ptaków wodnych. Postacie larwalne kolcogłowów zebrano z 1 gat. *Isopoda* — *Asellus aquaticus* L.

Zanalizowano skład gatunkowy fauny kolcogłowów jeziora wyróżniając gatunki:

a. dominujące — *Acanthocephalus lucii* Müll. u ryb, *A. ranae* Schrank u płazów i *Filicollis anatis* Schrank u ptaków.

b. rzadziej spotykane, ale zamykające swój cykl życiowy w obrębie badanego zbiornika. Są to pasożyty ryb — *Acanthocephalus anguillae* Müll. i *Neorhynchus rutili* Müll.

c. obce dla biocenozy Drużna i pochodzące z innych zbiorników: *Corynosoma strumosum* Rud. jako element bałtycki oraz *Polymorphus minutus* Goeze.

Ostatecznych żywicieli dla gatunków pospolitych, dominujących uszeregowano według stopnia zarażenia kolcogłowami, wyróżniając żywicieli dominujących i drugorzędnych. Za głównego dominującego żywiciela uważa autorka ten gatunek, u którego stwierdzono najwyższą intensywność, ekstensywność i średnią zarażenia. Żywiciele o mniejszych wskaźnikach zajmują kolejno drugie, trzecie itd. miejsce.

Żywicielami dominującymi są: wśród ryb — *Perca fluviatilis* L., *Acerina cernua* L., *Esox lucius* L.; wśród płazów — *Rana esculenta* L., wśród ptaków — *Anas platyrhynchos* L. i *Fulica atra* L.

Stwierdzono, że jedynym żywicielem pośrednim dla dominujących gatunków kolcogłowów jest na Drużnie *Asellus aquaticus* L. W żywicielu pośrednim pasożyty występują bardzo nielicznie (przebiegnie 1,1% zarażonych ośliczek), dopiero w żywicielach ostatecznych obserwuje się znaczne ich zagęszczenie, wzrasta wybitnie intensywność i ekstensywność zarażenia. O intensywności zarażenia decyduje, zdaniem autorki, to, jaki odsetek pokarmu żywicieli ostatecznych stanowi *Asellus*, a z drugiej strony działać tu mogą mechanizmy związane ze specyfiką stosunku pasożyt-żywiciel.

Zauważone zmiany sezonowe w zarażeniu pozwalają przypuszczać, że długość życia osobniczego u pospolitych w biocenozie jeziora gatunków kolcogłowów nie przekracza roku.

Autorka zanalizowała strukturę płciową populacji *Acanthocephalus lucii*, *A. ranae* i *F. anatis* stwierdzając, że stosunek ilościowy płci u tych gatunków charakteryzuje przewaga samic 1,5:1. Na podstawie dokonanych obliczeń wydaje się, że stosunek taki jest korzystniejszy dla populacji niż stosunek 1:1

